Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/GB05/000173

International filing date: 17 January 2005 (17.01.2005)

Document type: Certified copy of priority document

Document details: Country/Office: GB
Number: 0400984.1
Filing date: 16 January 2004 (16.01.2004)

Date of receipt at the International Bureau: 16 March 2005 (16.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   De La Rue International Limited
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   Patents ADP number *(if you know it)*

   If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — Security Document with Threads

5. Name of your agent *(if you have one)* — BOULT WADE TENNANT

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

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Security Documents with Threads

The current invention is concerned with providing security documents with features for visual inspection by members of the public. More specifically the current inventions relates to a novel security paper containing elongate security elements for the purposes of public and non-public verification.

The inclusion of elongate elements or security threads into security paper is well known and has been widely described within patent literature. Such threads may be wholly or partially embedded into the paper. It is usual to refer to partially embedded threads as being windowed, as the thread surfaces at regular intervals on the paper surface like a series of windows. A number of methods for producing security papers with so-called windowed threads have been described one of which is described in EP59056. Paper is still regularly produced by the method described within EP59056 and sold commercially under the trade name Stardust®.

EP59056 describes a method of manufacture of windowed thread paper on a cylinder mould papermaking machine. The technique involves embossing the cylinder mould cover and bringing an impermeable elongate security element into contact with the raised regions of an embossed mould cover, prior to the contact entry point into a vat of aqueous stock, referred to as a Stardust track. Where the impermeable security element makes intimate contact with the raised regions of the embossing, little or no fibre deposition can occur. After the paper is fully formed and couched from the cylinder mould cover, the water is extracted from the wet fibre mat and the paper is passed through a drying process. In the finished paper the contact points are present as exposed regions that ultimately form windows, visible in reflected light, on one side of the paper.

The use of windowed security threads has proved to be a highly effective security feature. However as threads have developed and become more complex with the introduction of text, colour shifting features and holographic designs there has been an increasing need to increase the width of the threads and thus the visual impact associated with the thread. This is particularly the case for holographic threads where the visual impact of the thread is very much dependent upon the area that is exposed

and thus viewable. To this end there has been a constant drive amongst security paper makers to produce security paper with wider threads.

To this end the method described within EP59056 has been developed and enhanced to enable embedding of wider threads into the paper substrate. EP860298 describes one approach for the embedding of wide threads, that is threads having a width 2mm or greater, in to paper. A first paper web is manufactured according to the method described within EP59056 and to this a second thinner paper web is applied thus masking any fortuitous flaws on the reverse of the paper web. Though effective the method described in EP860298 is not suitable for all types of paper machine.

Another alternative approach to the embedding of wider threads is described within patent application WO03095188 filed in the name of De La Rue International Limited. Here the shape of the window bridge is modified to allow for improved water dispersion and to prevent the bridge splitting as the paper passes through the press section of the paper machine.

The present invention provides an alternative solution to the need for providing increased public security. Rather than introduce a single very wide thread the inventors have accepted the width limitation and further recognised that a similar, and in some cases greater visual impact can be achieved by embedding two threads in to the paper simultaneously and in close proximity to one another, preferably in a windowed format.

To this end two or more threads are incorporated into a single sheet of paper in close proximity. The proximity of the two threads is crucial to the invention as explained later.

It is recognised that security documents have been produced that contain more than one thread, however in such examples the two threads have been introduced to provided different types of protection. For example one thread may be present as a visual public security device and the second present for machine reading and providing no visual security. Indeed the machine-readable threads are usually designed to minimise their visual impact. Further to this both threads are placed such that they are not in close proximity indeed they are usually placed a sufficient distance apart to prevent a user being confused.

Dutch patent application NL9300515 filed in the name of VHP Ugchelen BV describes the embedding of two threads in to a security document. Within this application it is suggested that the two threads should be embedded one directly on top of the other. This does little to improve the public security of the document as one of the threads will be completely obscured.

Patent application WO03029003 filed in the name of Giesecke and Devrient GmbH also describes the inclusion of two threads within a security document for the purposes of improving the durability of the document. The threads are inserted such that they sit close to the edges of the finished document to prevent edge tear propagation. The main purpose is not to provide public security and even if it were the two threads are placed at so great a distance apart they act as two discrete security elements rather than functioning essentially as a single device as in the current invention.

An alternative approach would be to take multiple thread constructions and combine them into a single thread during or post production of the threads. One example of this is described in EP520060 filed in the name of Nacional Moneda Timbre. Here a thread is manufactured by twisting or braiding multiple filaments together. Each of the filaments is preferably a different colour or has different functional properties. However it should be noted that even though the thread is made up of several filaments it is still embedded as a single device. Indeed the filaments described within the above application are thin and when combined together do not produce a strong visual impression and require close inspection to validate the document, thus limiting the devices appeal as a public security element.

It is recognised that the principle of the invention within EP520060 could be developed and rather than thin filaments wider thread elements twisted, braided or more likely woven together to form a single device that could also be embedded. Each of the thread elements should be of width of at least 0.5 mm in order for it to provide reasonable public security benefit. Indeed if the thread element is intended to carry text for public inspection such as described within EP319157 filed in the name of Portals Limited then it should be of a width of at least 1mm to allow easy public inspection. An approach similar to this is described within DE19809085 filed on the name Paugstadt. Here different threads are woven or spun together to form security

element that can then be embedded into paper. However such approaches are costly and create difficulties during the paper making approach and are therefore not preferred. Combining multiple different types in a braided, twisted or woven manner could be confusing to the public and actually detract from the public security of the individual elements.

It has been found that by placing two discrete elements in close proximity within a document provides significant benefits over wide, twisted, braided or woven thread constructions. Surprisingly when two or more threads are placed side by side they dramatically increase the overall visual impact of the security devices compared to having a single device, even if that single device is as wide as the combined width of the threads in close proximity to one another

There are several reasons for this which will now be explained under the headings "Area effect", "Complexity effect", "One feature leading to another effect", "Unexpectedness effect" and "Cross referencing effect".

Area Effect

The ability to see a security feature is in part dependant on the area it covers. When two or more threads are situated in close proximity such that they both appear near the centre of the field of vision, the viewer perceives the feature as covering an area bounded by the two outermost threads. This area is greater than the area of the individual threads and is thus more likely to be noticed.

Complexity Effect

Where the two or more threads in close proximity lead to a more complex visual effect than the separate viewing of the individual threads, the viewer is drawn to "investigate" the feature. This is because it represents an unexpected visual experience. The "chequer board" example demonstrates this effect.

One Feature Leading To Another Effect

This effect is well known in relation to security documents. When the security feature comprises two or more threads in close proximity at least on of which is more visible that the other(s) the viewer is drawn to the more visible feature and as a consequence

then sees the less visible thread(s). An example of this is two threads running in close proximity one of which is embedded (less visible) and the other is windowed (more visible).

Unexpectedness Effect

This effect is based on the observation that when two threads in close proximity comprise a windowed thread and an embedded thread the viewer is surprised when the embedded thread appears as a consequence either of the embedded thread being visualise by viewing in transmission or if it is fluorescent by viewing under UV light. The surprising nature of this experience leads to it being remembered and thus more useful as a security feature.

Cross Referencing Effect

This is a benefit obtained from having one thread that references directly and usefully to the other thread(s). An example is a thread with micro text that is hard to read but difficult to counterfeit and a second thread that has the same text but in a form that is easier to read but necessarily easier to counterfeit. The user is then prompted to check that the less visible text is correct and the security of the combined threads is thus enhanced.

It is to be understood that the terms 'security paper', 'security document' and 'banknote' in this specification include such items that are manufactured wholly from natural fibres (e.g. cotton or wood), partially from natural and partially from synthetic fibres (e.g. nylon, polyvinyl alcohol, viscose), and wholly from synthetic materials (e.g. spun-bonded polyolefin, polypropylene).

The invention will now be described in more detail by reference to the following figures.

Figure 1 illustrate an example of a prior art document containing a single wide thread.

Figure 2 illustrates a first example of a security document produced in accordance with the current invention.

Figure 3 summarises how two threads placed side by side within a document might be utilised within a security document.

Figure 4 summarises the approaches to producing selectively exposed threads.

Figure 5 summarises how windowed threads may be used for the purposes of carry simple codes.

Figure 6a, 6b and 6c shows a document with two threads that have been exposed selectively.

Figures 7a and 7b show documents containing two threads where the exposed windows define a first and second code respectively.

Figure 1 schematically illustrates an example of a prior art document manufactured according to EP860298 whereby a single wide thread is embedded into the paper. In this context a wide thread is considered to be any thread having a width greater than 2mm. Such wide threads have proved commercially successful and the additional exposed area allows for better use of optically variable devices and features such as diffractive elements, thin film interference devices, liquid crystal layers, OVI® layers and the like. This is particularly the case if such devices are to be utilised in combination with other features such as those described in EP319157 that results in some of the viewable surface being removed. However wide threads required sophisticated paper making equipment and can be costly to produce. The increased complexity of production, though acceptable and indeed beneficial for some applications, is not always appropriate for all documents. To this end a process was required that could make use of less complex paper making technologies but improve amount of exposed area of thread and thus the visual impression and public security.

Figure 2 illustrates a first example of a document produced in accordance with the current invention. Here two threads are inserted side by side and in close proximity. In this example the two threads have been inserted according to the methods described in EP59056. In this example a single window track has been embossed into the cylinder mould cover and both threads are inserted using this one window track.

The two threads may be the same or preferably are different. The ability to introduce two different types of security thread into a single document in close proximity allows for a range of novel effects that would not be possible or would be considerably harder to achieve on a single thread. Examples of such effects include.

- It is possible to create opposing kinetic and colour movement effects when using diffractive or holographic threads. The first thread is introduced in such a way that the movement effects move from top to bottom along the thread and the second thread introduced so the movement effects run bottom to top. This provides a striking visual feature that can be easily verified by the public. Further to this both threads may show the same type of movement effect or they may show different types of movement effects.

- In an alternative application two holographic threads may be used with mutually opposed image replay. That is at a first viewing angle the images on the first thread will replay strongly but the images on the second thread do not replay. Whereas at a second viewing angle the images on the first thread do not replay but the images on the second thread replay strongly. This mutually opposed variation is very hard to mimic and provides a strong security feature. In addition to the mutually opposed images both threads may have additional images that replay at substantially all viewing angles.

- The two threads may show different but related information to assist in verification. For example the first thread may have negative demetallised indicia detailing pertinent information whereas the second thread may have positive demetallised indicia detailing the same or different information. The threads will contrast in their visible appearance under both reflected and transmitted light. Such a contrast is visually very striking and again aids the process of authentication.

- The two threads may deliberately be designed for viewing in two different ways. For example the first thread may have demetallised indicia (positive or negative) produce in a size that is easily viewable by the human eye. Whereas the second thread may contain smaller text that may require a small magnifying glass or other such device to view. By placing the two threads in such close proximity it is far easier for the viewer to cross reference the microtext on the second thread to the main text on the first thread thus aiding authentication. A similar approach could be used with a first thread being printed with information visible in white light and the second thread being printed with information only viewable under non-visible illumination such as

UV light. Obviously non-visible feature can be combined with other visible features such as printed, demetallisation and holographic as is well known to those skilled in the art.

- A further example of where two threads can interact to aid in the authentication process is where a thermochromic thread is used. One such thermochromic thread is Thermotext® sold by De La Rue International Limited and described in EP608078. The Thermotext thread has a first and second viewing condition. The thread can be viewed in an unactivated state where the thermochromic ink is opaque and masks information printed underneath. In an activated state the thermochromic ink is warm and goes transparent to reveal the information underneath. Typically the information revealed will be pertinent to the product or item being protected. If a second thread is provided also displaying the information to be revealed the user will have a reference. Further to this the information of the second thread may be provided as a holographic image other such high security feature thus significantly increasing the protection against counterfeiting.

All the above examples refer to the embedding of only two threads in close proximity it is however perfectly reasonable to embedded more than two threads.

In this first example a relatively simple arrangement has been used for the process of embedding the two threads. It should be appreciated that a variety of other approaches can be used to create a variety of novel effects. These are summarised in the flow chart illustrated in figure 3 which we will now elaborate on is further detail.

The various embodiments possible have been subdivided into four headings, windows and bridges, registration, combination and interplay effects, and process. Before proceeding further these headings will be explained in further detail.

Windows and Bridges

Within this section we will highlight a variety of techniques and processes that can be used to embedded or partially embedded the threads into paper during the paper making process.

Registration

Within this section we will discuss the possibility of registering features on the threads to each other or other feature in or printed onto the paper.

Process

There a various methods by which the threads can be handled and embedded during the paper making process. Further to this there is a variety of different papermaking process that could be utilised when exploiting the current invention. Within this section we will provide an overview of the processes that may be utilised for the current invention.

Combination and Interplay Effects

The presence of two or more threads present an opportunity for the threads to interact at a variety of levels and in different ways. Within this section we will provide a summary of some of the methods and effects that can be achieved.

We will now refer to each of these headings in further detail.

Windows and Bridges

Windowed Threads

The use of windowed threads in security documents is well known and a number of techniques have been described within the prior art for the production of windowed threads. The most commonly utilised approach is that described within EP59056. In the example above we describe a method by which a single embossed window track on the mould cover is used for two threads, though it should be appreciated more than two threads could be embedded. Though it is preferable that a single window thread track is used for both threads it is possible that two or more different embossed window tracks could be used.

Indeed if more that one track is used it is possible to provide the exposed windows of the threads in an alternating pattern or indeed a variety of patterns. It is also possible to vary the number and size of windows on each thread so for example your first thread may be exposed four times over the width of the document whereas the second thread may be exposed six times over the width

of the document. The ability to alter the size and frequency of the windows independently for each thread can have additional benefits beyond the aesthetic value and these will be discussed later.

Thus far we have only referred to the threads being exposed on the one side of the document. It should be appreciated that the threads could be exposed on both sides of the document. Techniques for achieving this can be found in patent applications EP1141480 and GB0228423.0 both filed in the name of De La Rue International Limited.

Shaped Bridges

On the majority of security documents it is normal to produce windows having a regular rectangular shape, as illustrated in figure 2. However it has previously been described in pending patent application WO03095188 filed in the name of De La Rue International that altering the bridge shape can have both process and security benefits. Within the above patent it is proposed that by providing the leading edge, with reference to the machine direction on the paper machine, of the bridge at an angle which is not 90° to the machine direction significant process benefits can be gained. Further to this the angled or chevron bridge is visual distinct from traditional window bridges and therefore has greater public impact and security. It has also been found that such bridges can be used to define characters and geometric shapes which provide further security enhancements.

The technique described within WO03095188 is well suited to the current invention and it has been found that additional benefits can be gained by using the two techniques in combination. Specifically it has been found that when the angled bridges are used as part of a character the use of multiple bridges greatly enhances the visualisation of the characters in reflected light. This is because a greater area of the character is exposed particularly when the threads are inserted with a staggered confirmation i.e. two separate embossed window tracks slightly offset from each other. The slight separation between the two threads further aids visualisation compared to a single wide thread by increasing the area over which the device works as a whole.

Wholly Embedded

Thus far we have described instances where both the threads are exposed at regions on the surface of the paper. It should however be appreciated that one or even both threads could conceivably be wholly embedded within the paper. Though not a preferred approach for producing a public security feature for viewing in reflected light the embedding of threads is still viewed as high effective public security feature when viewed in transmitted light, that is, as you would view a watermark.

Provision of Holes in Paper

As an alternative to exposing the threads in a window one or more of the threads could be exposed in a hole or aperture formed in the paper as described within co-pending patent application WO04001130 filed in the name of De La Rue International Limited. The above relates to improvements in methods of making security papers with an thread partially embedded therein and having at least one discrete aperture extending through the security paper exposing at least a part of the thread, wherein at least one edge of the thread is exposed in the aperture.

The above novel approach could be used in combination with the more traditional window or on its own. The two threads may be exposed in the same aperture or two different apertures. Alternatively only one thread may be exposed in an aperture and the other thread wholly or partially embedded as described above.

Selectively Exposed Threads

The windows described thus far have exposed the threads over their full width and selectively along the length. It is equally feasible to selectively expose the threads across their width instead of or in combination with selectively exposing them along their length. Further detail on how this might be achieved will be provided later in this document by reference to specific examples.

Denominating Windows

The ability to control the manner in which the threads are exposed across there width and along their length also introduces the possibility of introducing codes which could be read manually or by machine. Such codes could be used

for identifying a particular series of denomination of document. Further detail on how this might be achieved will be provided later in this document by reference to specific examples.

Registration

Currently it is normal to provide threads with repeating patterns or features along their length in order to avoid the need to register the threads to the paper in the machine direction during paper production. However significant security advantages could be achieved if it were possible to register the thread design or features to the paper in the machine direction. That is it would be possible to ensure specific design elements on the thread sit in the exposed windows or under the embedded regions. For example demetallised designs could be position such that they are only present in the embedded regions of the thread ensuring that in the window regions the full surface of the thread is available to be viewed. One approach to producing paper with threads registered to the paper is described in pending application GB0228424.8. The teaching present within this particular case is equally applicable to the current invention.

Thread Design to Paper in Machine Direction

In an analogous example to that discussed above one or both threads could be inserted such that the thread design(s)/feature(s) is registered with the paper in the machine direction. The thread design could be registered to the windows/bridges on the window track or alternatively to other paper features such as watermarks, or electrotypes. Though technically challenging the resultant paper would be secure and extremely hard to counterfeit.

In some instance it may be preferable to only register one thread to the paper with the other thread being provided with a repeating design or features that do not require registration.

Thread Design to Print Design

As an extension to the idea of registering the thread design/feature to the paper it follows that you should also be able to register print applied onto the paper to the thread design. This would further enhanced the security of the resultant document as you are providing a coherent link between the substrate, and

inclusion in the substrate and your print working applied onto the substrate. As for the above example one or both threads could be provided in register.

Thread Design to Thread Design

As a further alternative it should also be possible to register the designs or features on the two or more threads to each other. In this instance neither of the threads need be registered to the paper or print, though it would be preferable to do so.

The ability to register designs or features on two or more threads in close proximity would be particularly beneficial when the thread contains recognisable images or diffractive devices. Providing registration between the two or more threads would make it even easier for the public to associate the two devices and thus improve the public security of the document.

Process

Cylinder

It is preferable that the cylinder mould paper making process is used when manufacturing the current invention. The cylinder mould process is ideally suited to the manufacture of security papers and in particular security papers containing threads and high security watermarks. As indicated previously methods for manufacturing paper according to the invention can be found in EP59056, EP860298, GB0228423.0, WO04001130 and EP1141480. In addition to these further alternative process utilising the cylinder mould process could be used these include the multi-layer techniques such as those described within EP229645.

Fourdrinier

Though the cylinder mould paper making process is the preferred approach it is also possible to make use of the fourdrinier process. One example of paper containing windowed threads can be produced using a fourdrinier paper machine is described within GB2260772 filed in the name of Portals Limited. This process can be utilised to produce paper according to the current invention.

Split Threads on Entry

In addition to the paper making techniques used it should also be noted that the manner in which the thread is supplied to the machine could vary. In a simplest embodiment each thread would be stored and unwound from separate bobbins, as is the case when embedding multiple threads across the width of a web on a paper machine. The only differences being that the threads are inserted into the papermaking machine in much closer proximity.

In a first alternative if the two or more threads to be inserted next to each other are of the same type then a single wide thread may be stored on a single bobbin. As this single wide thread is unwound from the bobbin it is slit into two, three or more threads as required prior to entry into the paper forming VAT and contact the mould cover or paper wire. Such an approach would allow for easier control of thread-to-thread registration.

Though preferable for two or more threads of the same type the above approach could also be used if two different threads were to be used. Here the wide thread on the bobbin would be asymmetric with one half across the width defining a first thread type e.g. plain metallised magnetic thread and the second half across the width would define a second thread type e.g. demetallised Cleartext.

Mark Prior to Insertion

WO03023140A1 filed in the name of Mantegazza Antonio Art Grafichi Srl a method is described by which threads are marked immediately prior to their inserting into the paper-forming vat. The threads may be marked with alphanumeric information, designs, serials numbers or the like and by controlling the marking process it is proposed that the designs can be inserted in register to the paper features. Such an approach would be equally applicable to the current invention.

Combination and Interplay Effects

Split Features onto Multiple Threads

One of the major advantages of the current invention is it allows features to be placed onto two or more threads rather than trying to produce extremely complex threads with many features. This has two distinct benefits; firstly the construction of the security threads can be greatly simplified with fewer

process steps being required for each thread compared to producing a single thread with multiple features on it. Secondly threads with numerous features on can be complex and confusing to the public. Indeed certain combinations of features can in many way conflict with each other. For example the use of demetallised threads is increasingly common and in particular threads of the type sold under the trade name Cleartext®. Such threads can be produced using plain metal layers or with optically variable diffractive devices.. In order to view the optically variable effect a reflection-enhancing layer is required. For security threads this reflection-enhancing layer is typically a very thin metal layer. It is increasing desirable to have both a diffractive and a demetallised design on security threads. Unfortunately the demetallisation process that defines the demetallised feature by its very nature removes the metal layer that enables the diffractive effect to be seen. Consequently it is necessary to either limit the size of the demetallised characters or increase the width of the thread to allow the diffractive effect to be seen. The current invention overcomes this problem by allowing the diffractive effect to be on a first thread and the demetallised feature to be present on a second discrete thread thus allow greater co-operation between the two devices.

Overt + Overt

The example above represents a combination of two overt security features and is thus referred to as overt + overt. Elaborating further on the above example it is preferable that diffractive and demetallised designs reflect each other in some way or they may even be repeated. By providing a strong visual link between the two you improve the public security as it is obvious that the two devices are related.

There are a great many variants of public security threads that could be used in combination with each other. Public security threads include those having, demetallised designs, thin film interference structures, liquid crystal layers, thermochromic layers, photochromic layers, iridescent layers, multiple different coloured metal layers, print layers. It is not uncommon for a security thread to use a combination of two or more of these public functional layers.

Some example of specific combinations of overt security threads was given in the preamble and hence will not be repeated here.

Overt + Covert

Rather than use two or more overt threads and overt thread could be used in combination with a covert thread. A covert thread is one that has some machine readable property. The covert thread may be designed such that it is hard to visualise when embedded into paper though it is preferable that it also have some overt feature to best make use of the current invention. Examples of covert threads included those with magnetic properties (which may be coded), luminescent properties, conductivity or other machine detectable characteristics.

As indicated it is preferable that the covert property be combined with some other overt feature on the thread. For example the detectable layer may be masked by an opaque metal layer and this opaque metal layer would provide an overt feature that can be viewed by the public. As a further enhancement rather than a plain metal layer the detectable layer could be covered by a diffractive device. Indeed many of the overt layers illustrated above could be used in combination with a covert detectable layer.

Covert + Covert

As a further development of the above two ideas two covert threads could be utilised. Again one or both could be provided so they are not easily visualised though it is preferable they do both have an overt public function as well.

Tessellating Threads

As yet we have assumed that the threads are of a constant width along their full length. This need not be the case and the threads may vary in width along their length in a regular and repeating manner. Examples of this can be found in EP70172 filed in the name of Portals Limited. In this instance the threads may be inserted into the paper such that the two threads tessellate with other.

So far we have summarised the approaches and methods for producing document containing two or more threads in close proximity. We have also touched upon the different classes of threads that might be embedded in combination to create striking

visual effects or a combination of overt public benefits and covert non-public benefits. During this discussion we have touched upon two additional areas namely the selective exposure of threads and the use of threads for denominating. Both these aspects are considered to be novel in their own right and are equally applicable to traditional security document containing single threads but have been found to be particularly beneficial when producing document containing multiple threads, these two concepts will now be discussed in more detail by reference to figure 4 and 5.

Considering first processes for the selective exposure of threads, summarised in figure 4. For many years threads have been inserted into paper using a variety of techniques and as discussed previously the most commonly used technique it that described within EP59056. Whereas this technique has proved very successful it should be recognised that the skill of counterfeiters and forgers has moved on significantly since this technique was originally developed. One approach to increase the document security is to use increasingly complex threads and expose these using larger windows, such as proposed in EP860298. WO03095188 also been proposes altering the shape of the windows for production reasons but it should be noted that this also has public security benefits and increases the difficulty of producing counterfeits.

A further alternative approach proposed here is to increase the complexity of the window region. A range of techniques have been developed that allow threads to be exposed in more complex and interesting ways than previously possible. Such approaches can be used with any of the security threads currently being utilised and can also be used for both wide (>2mm) or narrow (<2mm) threads.

Referring to figure 4 the flow chart illustrate the various elements that need to be considered with respect to the current idea. Not all these will be considered in detail here as they have been touched upon already earlier within thins document. We shall therefore focus on the section titled "*Windows and Bridges*".

Windows and Bridges

Electrotype Bridges

Currently the majority of documents containing windowed threads are produced using a cylinder mould paper machine. The mould cover of the cylinder mould machine is embossed with a window track. This window track is a series of regular undulations forming peak and troughs. When the thread

is inserted in to the paper is brought to lie in contact with the peaks and thus raised above the troughs. The window track is in fact a special type of watermark designed specifically for the purpose and if a document is containing a windowed thread is viewed in transmission the window track can be visualised as a watermark. Another special class of watermark is an electrotype. Here a raised impervious element is applied to the mould cover to prevent fibre deposition. Rather than resulting in a multi-tonal watermark electrotypes result in this regions of paper which when viewed in transmission give rise to single tone images. It should however be noted that recent developments have been moving towards multi-tonal electrotype designs, see EP1122360 filed in the name of Arjo Wiggins SA.

Electrotypes tend to cover small areas and can have relatively fine designs. It is proposed that rather than use a traditional embossed window track to exposed the security thread the use of electrotypes allows for a much greater range of window shapes and more complex window shapes. The use of electrotypes has allowed for the production of papers containing windowed threads where the windows themselves define information, designs or patterns.

Figure 6a shows an example of paper containing two threads that have been selectively exposed using electrotypes rather than an embossed window track. In this example two different electrotypes have been used the first is a star and the second is the letter P. Both electrotypes have been used for both threads in a repeating manner. It is preferable that the electrotype selected reflects some other design element present on the document within the watermark or print. This further enhances the security by providing some continuity between the various features making the document easier to comprehend and understand for the public.

Electrotype Bridges in Embossed Window Tracks

As a further enhancement of the above it has also been found that electrotypes can be used in combination with the traditional windowed thread tracks to producing striking a novel effects. Figure 6b shows an example where a star electrotype has been used in the first embossed thread track and a P electrotype has been used in the second embossed thread track. In both case

the electrotypes have been position so they partially expose the thread in the bridges. That is to say on the embossed mould cover they sit in the toughs where paper would normal deposit to form a complete bridge.

This approach allows for the benefits of a large window to expose the thread such that any features such as diffractive devices on the thread can be easily visualised. But in addition also provide the more complex and much harder to counterfeit electrotype derived complex windows.

Chequer Board Bridges

Figure 6c shows a further variant whereby each of the threads is only partially exposed across its width to create a chequer board effect. This effect is again achieved by modifying the mould cover of the cylinder mould machine. Here use is made of an embossed, or on a smaller scale electrotype, in a chequer board pattern through which two or more stardust threads are passed. The thread windows on the raised (or light) portions of the emboss or the electrotype. For this application the width of the thread is not critical, as typically the threads will wander in a 12 mm range and so will appear in different parts of the chequer board pattern. By having two threads present rather than one you increase the area of thread exposed and hence enhance the visualisation of the chequer board pattern.

Bridges/Windows That Confer Information

As illustrated above the ability to provide more complex bridges has significant benefits. One key benefit being that the novel bridge shapes can form characters, simple images, geometric shapes, patterns or other indicia. Such features can then be used to convey information to the viewer. For example the complex bridges might define denomination information, the initials of the issuing authority or replicate a demetallisation design on the thread itself. Furthermore the interplay between the threads and the watermark in the window regions markedly increases the complexity of the technical challenge facing a would be counterfeiter.

As indicated previously the ability to provide simple repeating themes at multiple levels within the design of a security document is of major benefit when considering public security. A document and thus a documents various

components needs to be instantly recognisable and any discrepancies obvious to a viewer. As the public tend to spend very little time inspecting a document and typically relay on very few of the security features present it is essential that as strong a visual impact is made in that time as possible.

Paper with Holes and Complex Bridges

It should also be noted that the complex bridge designs need not be used in isolation or just with traditional bridges. They can be used with any of the other known paper security features but it has been found that they are particularly effective if used in combination with the hole in paper feature previously referred to an described within WO04001130. The presence of a hole extending through the body of the paper instantly draws the public attention to that region of the document. Then the use of complex window designs further holds the attention of the public drawing to further at the features present both in the paper and on the thread thus enhancing security.

Two Sided

Thus far we have only referred to the thread being exposed on one surface of the paper. It should be recognised that the use of complex windows is equally applicable to instances where the thread is exposed on both sides of the paper.

Denominating Windows

In a further development it has been found that configuration of windows on a security document can be used to define a code. The size frequency and shape of the windows can be used to define a public or machine-readable code to confer information relating to any aspect of the document. It has been found that the use of threads to provide information relating to a document or series of documents can be achieved with a single thread but with the presence of multiple threads there is an opportunity for a much greater number of coding options. For the purposes of clarity herein we shall refer to the windows providing denomination for a series of document but it should be recognised that the window configurations could be used to provide codes for a variety of purposes. The concept will now be discussed with reference to figure 5.

Single or Multiple Threads

As indicated above the current concept is equally applicable to document containing single or multiple threads, however herein we shall focus on the use of multiple threads.

Number of Coding Options

The presence of multiple threads allows for an increased number of coding options and obvious the more threads used the more coding options are present. A variety of factors can be used to define the code all of which may be used in isolation or in combination. These factors include window size (width and height), window shape, window frequency, window position along the length of the thread and window position with respect to a window on an adjacent thread.

Figures 7a and 7b illustrate a simple example of the current concept. Here a series of documents has been produced containing two threads. The documents could be a new series of banknotes comprising five different denominations and each denomination would have its own code. Alternatively the documents could be a certificate of authenticity (COA) for software or computer products where the code would define information other than value, for example the type of product the COA is to be applied to, the region from which the COA is issued, the replicator issuing the COA etc.

In this example each document has two threads, a first thread embedded in track A and a second thread embedded in track B. The code is defined by the size and frequency of the windows in both tracks. In this instance track B is used as a reference track. That is to say every single document in the series will always have a consistent code in track B. The presence of a reference track is advantageous for a number of regions such as the ability to out sort non-relevant document, provides a reference from which to locate the code track, provide a calibration code which could be used to help accommodate for any soiling or damage to the document.

Thus in this example the code is defined from the track A alone. For the document shown in 7a track A can be seen to comprise a thread having four windows and three bridges. For the document shown in 7b track A can be

seen to comprise six windows and five bridges. Thus it can be clearly seen than the two documents can be distinguished from each other. This number of windows and bridges could then be cross reference to a central source to determine additional information as indicated above. The central source could be a database held on a computer either locally or remotes and accessed via a network or internet connection. Alternatively in stance where the use of a computer is not possible or appropriate a simple printed table could be provided. Alternatively rather than manually checking the code the code could be read using suitably adapted cash handling equipment or a handheld device. Such devices would look at the reflectance of light from the document along the length of the thread.

Information Conferred from the Code

As described in the above example the code could be read and cross referenced to external source be that a computer database, look up table or even a printed reference document. As an alternative the threads could be designed to confer information about the document directly without the need to an external source.

Referring again to figures 7a and 7b consider in this instance that the two documents illustrated are two banknotes of different denominations from a series. The frequency of the windows could be used to provide the viewer with confirmation that the paper used is the correct paper for the denomination information printed on it. It is known for forgers to take a low denomination note and remove the ink. They then reprint the document as a higher denomination. This is a particular issue in countries where all notes for all denominations are of the same size.

In this example the number of windows on the thread in track A would define the first numeral of the denomination and the number of windows on the thread in track B would define whether the first numeral is in ones, tens hundreds etc. So in this example figure 7a shows a document having a value of 400 and figure 7b shows a document having a value of 600. As a further illustration a document having a value of 5 would comprise a thread in track A with five windows and a thread in track B with one window. Likewise a

document with a value of twenty would have a thread in track A with two windows and a thread in track B with two windows.

Code Also in Machine Readable Form on Thread

Above we have already suggested that the code defined by the windows could be read manually or by machine. As an alternative or in addition to the window code being read by machine it is possible to provide a covert machine readable code on the thread as well. This could be done by providing the thread with a magnetic coding such as that described in EP407550. This code could provide different information to that provided by the window code or the same information.

It should be appreciated that the windows on the thread(s) could be formed according to any of the techniques utilising any of the processes described already within this document. Likewise process enhancement such as paper/thread and thread/thread registration could be used to further enhance the effectiveness of the invention.

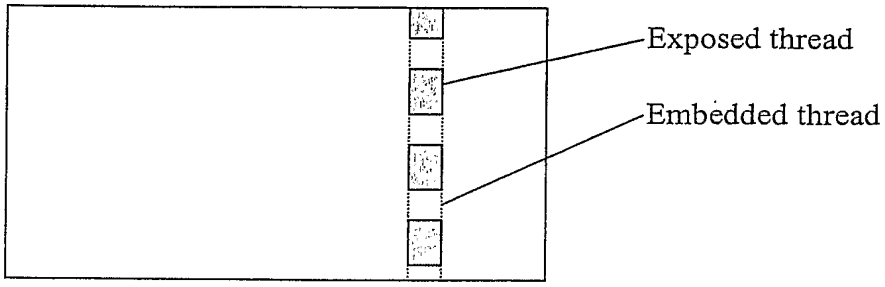

Figure 1

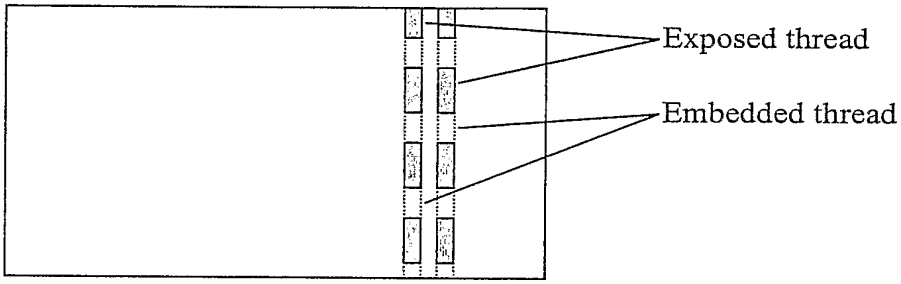

Figure 2

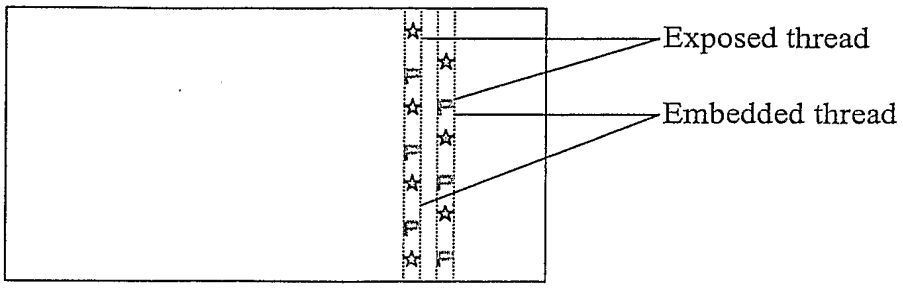

Figure 6a

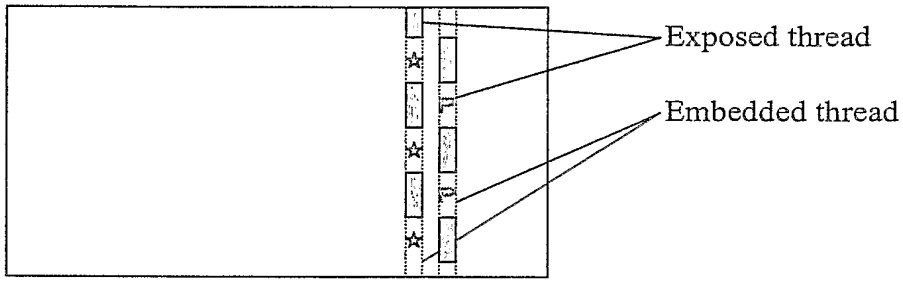

Figure 6b

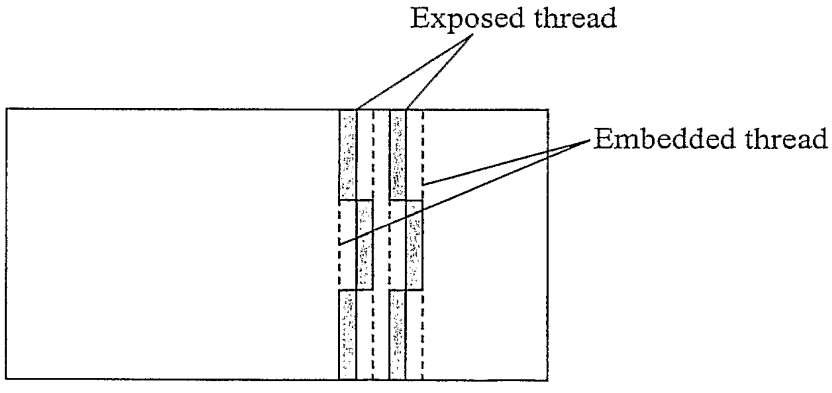

Figure 6c

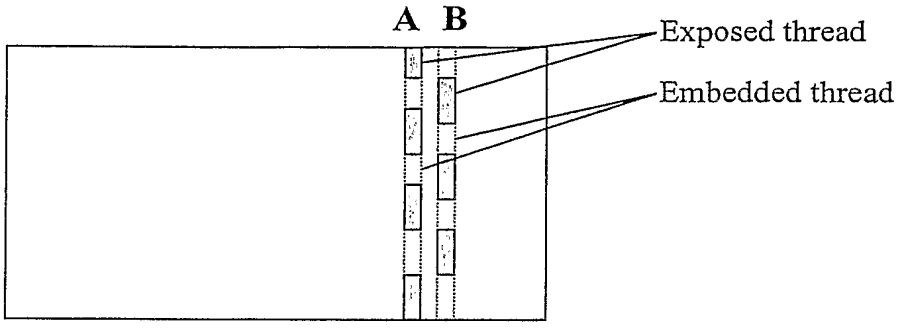

Figure 7a

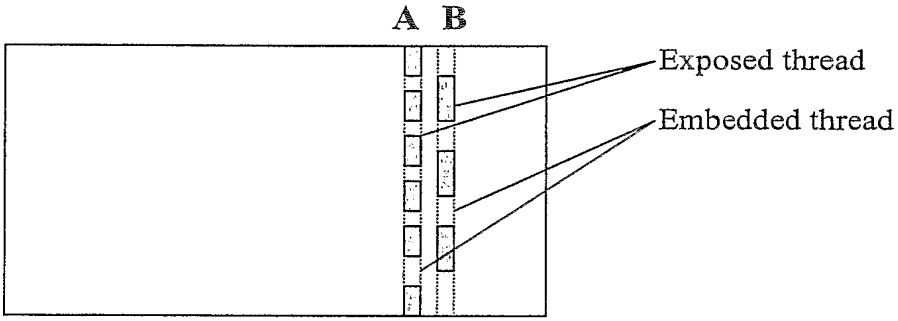

Figure 7b

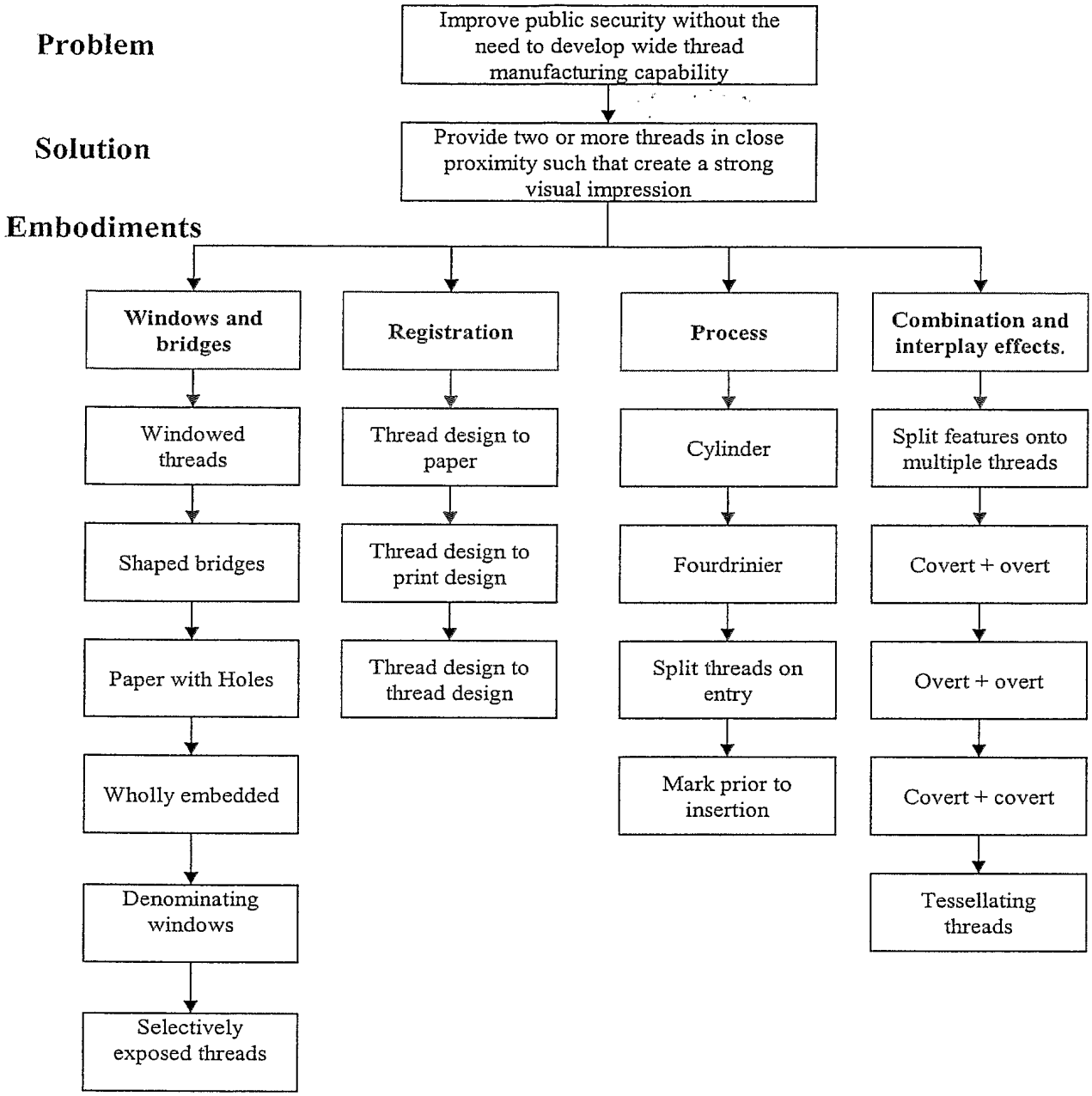
Problem
Improve public security without the need to develop wide thread manufacturing capability
Solution
Provide two or more threads in close proximity such that create a strong visual impression
Embodiments
Windows and bridges
Windowed threads
Shaped bridges
Paper with Holes
Wholly embedded
Denominating windows
Selectively exposed threads
Registration
Thread design to paper
Thread design to print design
Thread design to thread design
Process
Cylinder
Fourdrinier
Split threads on entry
Mark prior to insertion
Combination and interplay effects.
Split features onto multiple threads
Covert + overt
Overt + overt
Covert + covert
Tessellating threads

Figure 3

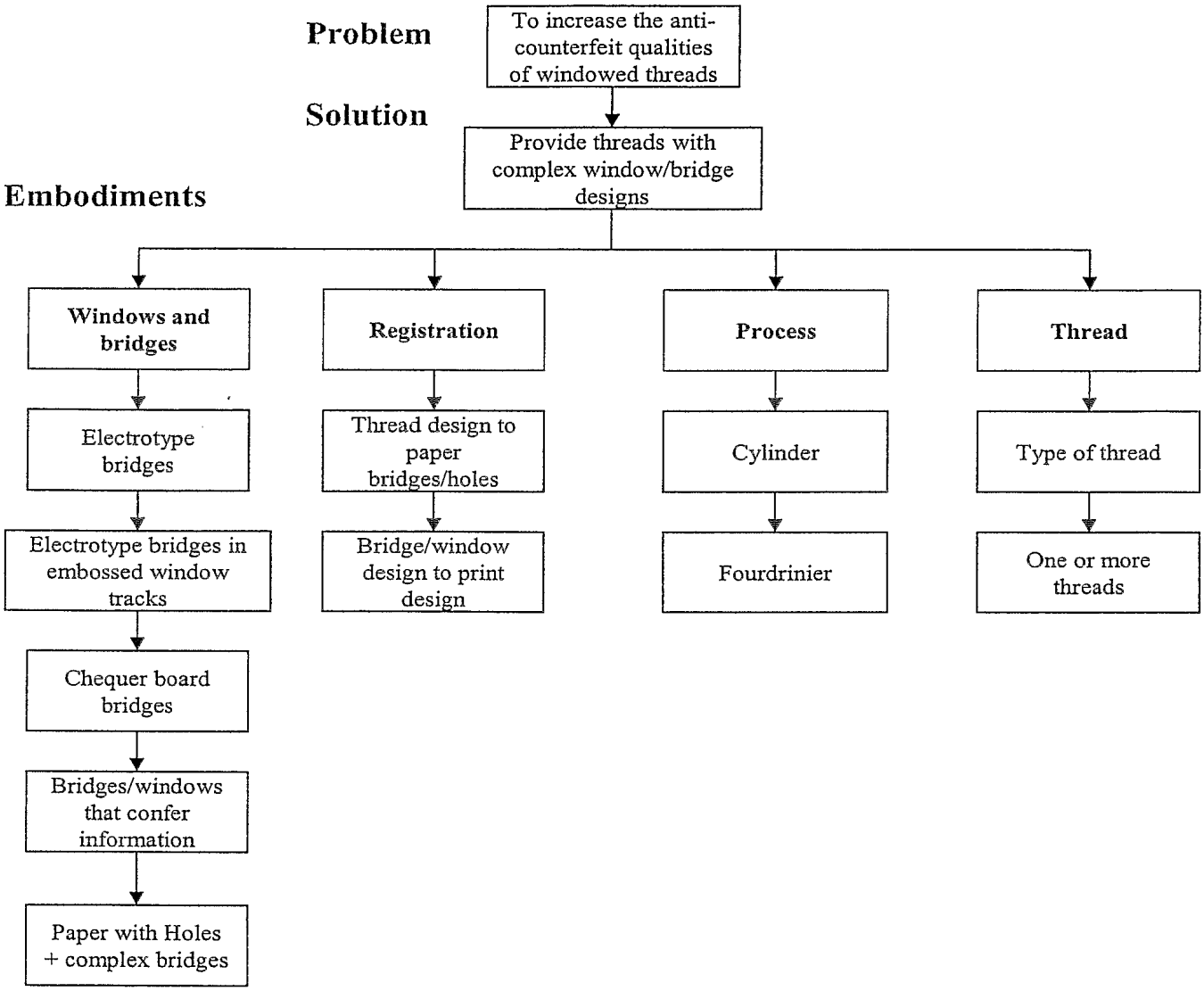
Problem
To increase the anti-counterfeit qualities of windowed threads
Solution
Provide threads with complex window/bridge designs
Embodiments
Windows and bridges
Registration
Process
Thread
Electrotype bridges
Thread design to paper bridges/holes
Cylinder
Type of thread
Electrotype bridges in embossed window tracks
Bridge/window design to print design
Fourdrinier
One or more threads
Chequer board bridges
Bridges/windows that confer information
Paper with Holes + complex bridges

Figure 4

Problem

The need to be able to denomination documents rapidly

Solution

Window size, shape and frequency is varied for each denomination

Embodiments

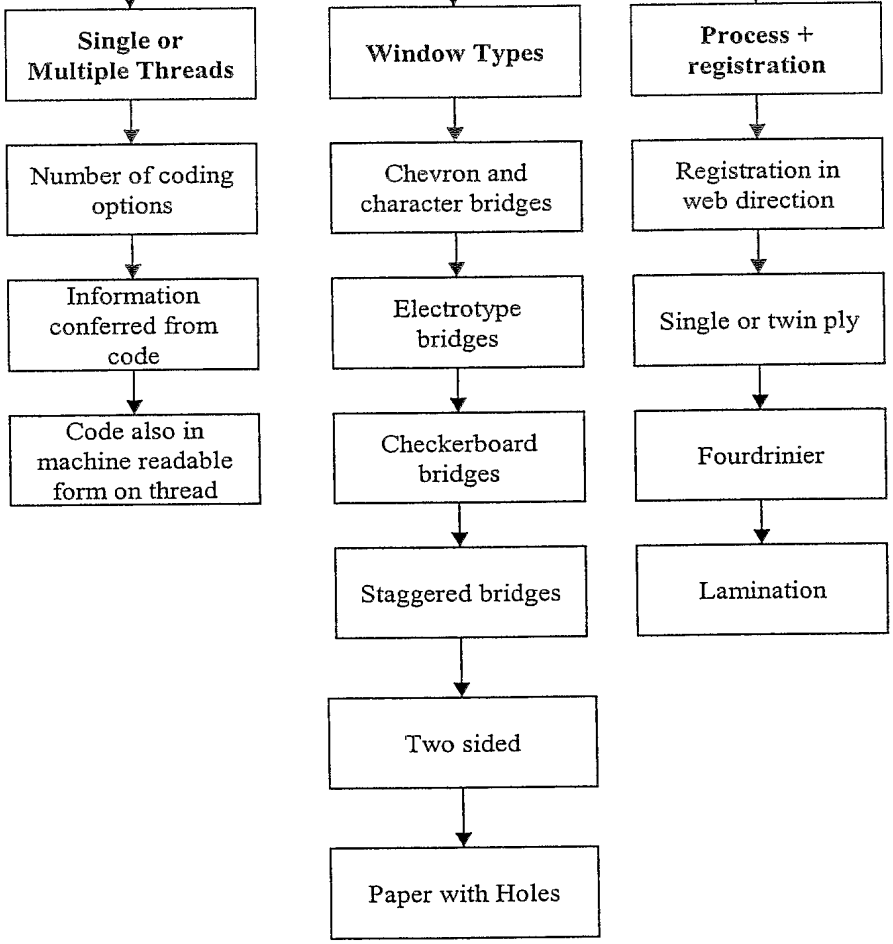

Figure 5